HYPROFESSIONALS

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0 Executive Summary

In the future today's students and technicians will be responsible for design and production of fuel cells as well as users too. Therefore education at the moment is an important step forward for an increasing acceptance and successful implementation of hydrogen and fuel cell technology.

The focus of this report is to assess hydrogen and fuel cell educational materials which are used in a number of different educational systems at different European levels.

The report gives a review of currently available hydrogen teaching and training materials. In addition, opportunities to transfer hydrogen and fuel cell information into traditional materials were evaluate. This will in context to Education and Training System allow verifying in which way are singular and standard the studied initiatives.

By the gathered results of evaluation hydrogen and fuel cell educational materials the whole project HYPROFFIONALS will take advantage to going successful.

Table of contents

Index of figures

1 Objective(s) of the report

The deliverable D5 refers to task 1.2 in WP 1. The objective of the task is identification of currently available hydrogen teaching and training materials and assesses them.

The focus of the report is to find and evaluate hydrogen teaching and training materials from the origin countries of the partners involved in this task. The partners from for European countries which involved are UK, Spain, France and Germany. Therefore, the report gives a well based overview about European ways to provide the topics hydrogen and fuel cells to the audience.

2 Assessment of educational materials

2.1 Germany

Name of the materials:	Fuel Cell Technology - Lecture notes -
Authors / Institution:	Prof. Dr.-Ing. R. Ruderich, University of Applied Science Ulm, Germany
Language:	German
Date of compilation:	2008
Short description of the contence of the materials:	Chapters 01 Introduction 02 The Polymer Elektrolyte Membrane (PEM) Fuel Cell 03 Atomic and molecular thermodynamics 04 Fuels and chemical equations 05 The first law of chemical thermodynamics 06 Entropy and the second law of chemical thermodynamics 07 Gibbs function or free enthalpy 08 Characteristic diagram of a PEM Fuel Cell 09 Hydrogen as fuel
Number of modules / slides / hours of teaching:	The material contains 9 chapters and 3 exercise sheets and is the lecture note of a one semester, two hours per week compulsory elective subject.
Who is the target-group?	Enrolled students who want to fulfil their study program with special knowledge in the field of hydrogen technology.
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	Materials where provided during the lectures.
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	The attendees gets 2 credit points.
Are the materials public?	The material is not public and protected by copyright.
Contact:	www.hs-ulm.de
Comments:	The material as part of same named lecture provides a deeply rooted knowledge of chemical und thermodynamic processes in fuel cells. Moreover the student will be able to determine the parameter for optimal fuel consumption.

Fig. 01: Fuel Cell Technology – Lecture notes

The Ulm University of Applied Science is a special type of German institution of higher education and is accredited by the higher education act to award academic degrees. In contrast to the traditional universities have Universities of Applied Science mainly a practical and application orientation and less research. Therefore is a close relationship to the industry represented and makes students very attractive for employers.

Universities of Applied Science differs from vocational education in that they are only open for persons who have a secondary school leaving certificate or similar which is accepted by accreditation regulations. But in addition to the regularly study programs the most Universities of Applied Science offers a study program for already working persons who have a need for a particular knowledge as a postgraduate professional education. This could be an engineer or a doctor who need a business course to improve and broaden their knowledge for potential opportunities.

The lecture notes “Fuel Cell Technology” presented in figure +++ written by Prof. Dr.-Ing. R. Ruderich is an essential part of a same named compulsory elective subject. Usually the lecture notes where provided during the lecture or authorized students have the possibility to take it from the computer network. That’s why the lecture notes are not public. Moreover is in the beginning of the lecture notes “Fuel Cell Technology” explicit mentioned that this text is copyrighted by author.

The lecture notes “Fuel Cell Technology” provides a deeply rooted knowledge of chemical und thermodynamic processes in fuel cells. Moreover the students will be able to determine the parameter for optimal fuel consumption. The lecture notes “Fuel Cell Technology” contains 9 chapters and 3 exercise sheets and is the written basis of a one semester, two hours per week compulsory elective subject. The knowledge will be tested by a written exam.

Generally compulsory elective subjects where demanded by examination regulations of the University of Applied Science Ulm and gave students the possibility to partly create their own study program. In this case the lecture “Fuel Cell Technology” is in a pool of technical compulsory elective subjects and is open for any enrolled students who have to choose one or more of it. Number and necessity depends on the specific examination regulations for any particular study programs such as Industrial Engineering, Production Engineering and Organization or Automotive Engineering.

Name of the materials:	Hydrogen Technology, Master of Science (M. Sc.)
Authors / Institution:	DIU | Dresden International University
Language:	German
Date of compilation:	Duration of study: 2 years.
Short description of the contence of the materials:	Modules 01 Physics, Chemistry and Thermodynamics of Hydrogen 02 Generation of Hydrogen 03 Energy industry 04 Storage and handling of Hydrogen 05 Hydrogen applications to power cars 06 Fuel Cells 07 Safety aspects of hydrogen/ nuclear fusion 08 Hydrogen application in aeronautics and shipping 09 National and international activities at the intersection between science and politics
Number of modules / slides / hours of teaching:	The study program is divided into 9 modules. The knowledge will be tested by written and/or oral exams.
Who is the target-group?	Engineers, natural scientists, business graduates and political scientists who need special knowledge in field of hydrogen technology.
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	Materials where applied during the study program at DIU.
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	The attendees gets the academic degree Master of Science (M.Sc.)
Are the materials public?	The modules were provided as lectures for enrolled students.
Contact:	www.dresden-international-university.com
Comments:	The aim at this unique study program "Hydrogen Technology" (M. Sc.) is a related to practice combination of all hydrogen aspects supported by experiments and excursions.

Fig. 02: DIU | Dresden International University

The “Hydrogen Technology” Master of Science study program is provided by the Dresden International University in Dresden, Germany. The Dresden International University is an institution of higher education and is accredited by the higher education act to award academic degrees such as Master of Science or Bachelor. The Dresden International University offers study programs in German and English language open for German and international students. Among Bachelor study programs for undergraduates Dresden International University is mainly focused in the further education for graduates by providing Master of Science study programs and courses with a certificate of attendance.

The Master of Science program “Hydrogen Technology” as an extra-occupational course of study is addressed to Engineers, natural scientists, business graduates and political scientists who need special knowledge in field of hydrogen technology. Aim at this unique study program is a related to practice knowledge transfer of all hydrogen aspects supported by experiments and excursions. The study plan is divided into nine modules which are tested by written and/or oral exams. Accept the first two modules are positive exam results necessary to start the next module. Any kind of written study materials will be provided during the lectures and are not public.

The study plan is developed in a way that the first modules gave fundamentals about physics, chemistry, thermodynamics and generation of hydrogen as well as basis knowledge in energy industry and economy. The content of the following modules provide a currently range of hydrogen applications. The study plan will be complete by the ninth module which highlights the national and international activities at the intersection between science and politics. With passing the last module the students get the academic degree Master of Science. This interdisciplinary study program gave the possibility to work in this economic environment very successfully.

Through a continuous improvement process will be ensured that learning content follow the currant results from this dynamic field of research and development as well as changes in European and/or national support and development programs.

Name of the materials:	H2-Employment Teaching modules for Hydrogen technology
Authors / Institution:	Partners of the EU-Project H2-Employment: Colegio Oficial de Ingenieros Técnicos Industriales de La Rioja (SP), Fundación San Valero (SP), Servicio Riojano de Empleo(SP), Environment Park (IT), WBZU (GE), HyCent (Austria)
Language:	Spanish, English, German, Italian
Date of compilation:	2011
Short description of the contence of the materials:	**Chapters** 01 Environment, Energy and Hydrogen 02 Production of Hydrogen 03 Storage of Hydrogen 04 Handling of Hydrogen (05 Fuel Cells Fundamentals 06 Application of Fuel Cells (07 Batteries and e-Mobility 08 Hydrogen Internal Combustion Engines 09 Regulations and Codes 10 Exam
Number of modules / slides / hours of teaching:	The 10 modules summarize about 250 ppt slides and a multiple choice test. The materials enable courses with 2 or 3 days of teaching.
Who is the target-group?	People how need a working knowledge in the field of Hydrogen and fuel cells, e.g. engineers or technicians.
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	In the connection with the EU project a pilot action with three units took place in Logrono, Spain. One unit summarized 8 hours of teaching (starting Friday afternoon, ending Saturday morning). The target group were unemployed engineers.
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	Certificate of attendance.
Are the materials public?	The modules are provided as web-based-training. Students who register can download the slides and ask their questions to tutors.
Contact:	http://www.h2employment.eu

Comments:	The teaching modules developed in the frame of the EU project are singular at the moment which means that they are currently used in pilot actions and individual seminars. They are not standardized by an accreditation body and implemented in a professional or academic curricula.Due to the different educational systems in the European countries (Compare Deliverable 2) the accreditation of the teaching materials was not the aim of the project. In coordination with the different responsible bodies each EU country has to define its own way of implementing the topic in existing curricula. For this 'implementation process' the results of this procect can give important hints which topics could be considered in existing curricula.

Fig. 03: H2-Employment

This two year European project (2009 – 2011) in the frame of the Leonardo da Vinci program was coordinate by the Colegio Oficial de Ingenieros Técnicos Industriales de La Rioja (Spain) in cooperation with partners from Spain (Fundación San Valero), Germany (WBZU), Italy (EnviPark) and Austria (HyCent)

While in science and research there are many developments on going that result in applications in the European economy itself (sales of vehicles) the field of vocational training on a ‘technical level’ is often neglected. Comprehensive instructional contents for the training of occupational workers and professionals are necessary for successfully introduction of Hydrogen technologies in the European market.

With this background one task of the project was the development of teaching materials in English, Italian, Spanish and German (compare table +++). The materials address people who need a working knowledge in the field of Hydrogen and Fuel Cell technology. They present a good basis for continuing education and training of engineers, technicians and professionals. In the project for example the materials were used in pilot action to train workers with an occupational level and unemployed technician. The content of the modules are also transferred via e-learning.

The teaching modules developed in H2-Employment project are singular at the moment which means that they are currently used in pilot actions and individual seminars. As far as the author knows they are currently not standardized by an accreditation body and for that not yet implemented in a professional or academic curricula. Due to the different educational systems in the European union (Compare

Deliverable 2) the accreditation of teaching materials must be carried out by the member states. In coordination with the different responsible bodies of each EU country has to define its own way of implementing the topic in existing curricula. For this 'implementation process' the results of HyProfessionals can give important hints which topics could be considered in existing curricula.

2.2 Spain

Name of the materials:	Higher Vocational Training Programme in Energy Efficiency and Hydrogen Technology
Authors / Institution:	Partners of the EU-Project H2-Training: Fundación San Valero (SP), Hydrogen foundation of Aragon(SP), Environment Park (IT), WBZU (GE), Cardiff Metropolitan University (UK), Eco4ward(Austria), Grazer Energie Agentur(Austri), Kolping Bildungwerk(GE),FAST(IT)
Language:	Spanish, English, German, Italian
Date of compilation:	2008
Short description of the contence of the materials:	**Chapters** 01 Background. Hydrogen based economy 02 Hydrogen Features 03 Application of Hydrogen 04 Fuel Cells 05 Hydrogen production 06 Hydrogen storage 07 Handling of hydrogen 08 Security and healthness 09 Regulations and Codes
Number of modules / slides / hours of teaching:	The 9 modules summarize about 220 pages handbook . The materials enable courses with 40 hours of teaching.
Who is the target-group?	Future teachers in these studies
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	The recopilation compound a handbook as a proposal of study material for teachers formation
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	Certificate oaf attendance.
Are the materials public?	The material is a reference to furter formation programs
Contact:	http://www.h2training.eu/

Comments:	The aim of independent curriculum vocational training is that all citizens who follow this training achieve capacities and competences which allow them to: a) Develop the general competence equivalent to professional qualification or qualifications included in its equivalent further education award. b) Understand the organization and characteristics of a specific productive sector, as well as the professional mechanisms involved; to be familiar with the basic working legislation, rights and duties from a working relationship. c) Achieve knowledge and the necessary abilities to work in healthy and safe

Fig. 04: Higher Vocational Training Programme

Approved by the European Union under the program Leonardo da Vinci, is one of 18 selected innovation pilot projects in Spain in 2006.

The project focuses on the renewable energy field, and More specific, in the "new hydrogen technologies and fuel cells," according to the so-called "European Roadmap for hydrogen" that power new applications and increased use of these clean technologies, in response to international commitments of the EU itself (Kyoto). The project, as a European observatory and by developing prospectively actions, identify those international expert skills needs in the field of renewable energy and hydrogen technologies in collaboration with industry, institutional, scientific and specialist teaching in this field.

This function complements the prospective realization of a European curriculum design and development of training contents for trainers supported by international cooperation between institutions of excellence in scientific, technical and pedagogical development of a methodology-oriented experimental demonstration validate the quality of outputs and outcomes.

Objectives:

1. - Define a European curriculum design and development of training content in a new emerging professional profile (renewable energy and hydrogen technologies).
2. - Develop international reference materials for the training of trainers in the field of renewable energy and hydrogen technologies.

3. - Develop two pilot projects for training of trainers, on-campus with an international faculty, and another at European level through training "e-learning".
4. - Promote and strengthen the contribution of vocational training to the process of innovation to improve competitiveness and create new employment opportunities.
5. - Validate a methodology, outputs and outcomes through various pilot projects of international scope.

6. - Enter a transversal approach to support gender equality.
7. - To develop specific products for dissemination and valorisation of the project nationally and internationally.

Name of the materials:	Hydrogen and Fuel Cell Teaching modules for SEAS courses
Authors / Institution:	SEAS estudios abiertos
Language:	Spanish
Date of compilation:	2010
Short description of the contence of the materials:	**Chapters** 01 General Knowledge 02 Production of Hydrogen 03 Storage of Hydrogen 04 Applications fuel cells 05 Security 06 Project management
Number of modules / slides / hours of teaching:	The 6 modules summarize pages handbook. The study is supportted on a online platform from wich students progress is followed. The materials enable courses with a duration of 80 hours
Who is the target-group?	People how need a working knowledge in the field of Hydrogen and fuel cells, They don´t need previous related studies. People from 18
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	The taching material are applied by an online platform. Where the studient can study on his own and take contact with teachers online or by phone.
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	Certificate from Avila Catholic University and certificate by SEAS
Are the materials public?	The material are for teachers and students
Contact:	http://www.seas.es/cursos/hidrogeno-y-pilas-de-combustible
Comments:	During the course, they use programs and GRHYSO and HOGA (only supported for all versions of windows), for simulation and economic evaluation of hybrid systems optimzation of renewable sources in off-grid systems and connected to the grid, respectively.

Fig. 05: SEAS courses

The course of hydrogen and fuel cells includes all hydrogen chain starting with production and ending by use, through all the intermediate processes.

Over the course of hydrogen and fuel cells students can learn about the needs of searching an energy system based on energy sources that respect the environment.

The various hydrogen production processes, especially through renewable energy sources and physical and chemical principles to rule the chain of hydrogen. Also the various forms of hydrogen storage and how can be used in specific cases, followed by the basics, characteristics and components of a fuel cell and other applications of hydrogen. Basic safety behaviours, laws and regulations associated with the handling of hydrogen.

The course of hydrogen and fuel cell consists of six modules:

1. GENERAL CONCEPTS

Hydrogen: physical-chemical properties, hydrogen economy, introduction scenarios and hydrogen technologies.

2. HYDROGEN PRODUCTION

Electrolysis: fundamentals, types of electrolyze components and characteristics, current market.

Fossil fuels: reformed from natural gas, gasification. Solar Energy: thermo chemical cycles; photolysis; solar thermal cracking. Production from biomass: gasification, pyrolysis, biological methods.

Name of the materials:	EHY-1 Advanced technology on fuel cells
Authors / Institution:	LUCAS-NULLE
Language:	Spanish, English, German, Italian, French
Date of compilation:	2011
Short description of the contence of the materials:	**Components** 01 Fuel cell with DC converter 02 Electronic load 200W/20V/10A 03 Metal hydride storage cell with solenoid valve 04 Electrolyser, 30 Normlitre/hour (1.06 cubic feet/h, 7.93 gallons/h, 30000 cc/h) 05 Monitoring software 06 CD-ROM with theory related modules as a course
Number of modules / slides / hours of teaching:	The theory consists on 8 modules with practices explained and a multiple choice test.
Who is the target-group?	People how need a working knowledge in the field of Hydrogen and fuel cells, e.g. engineers or technicians.
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	These material can be applied in all kind of courses related to beginning in knowledge on fuen cells technology. Short courses and seminars as demostrations equipment
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	There are non certificated materials. There are from market manufacturer.
Are the materials public?	The material is public and and fixed to market and trade specifications.
Contact:	http://www.lucas-nuelle.com/316/apg/1266/EHY+1+Advanced+fuel+cell+technology.htm
Comments:	The generation of electrical energy using fuel cells continues to develop into a significant area with diverse application potential in electrical engineering and automotive technology. The training panel system permits a safe experimenting environment in connection with hydrogen and fuel cells. At the same it permits interesting investigations and is well suited for both practical lab work as well as demonstrations. Animated theory, experiment guidelines and information including results are supplied using the “Interactive Lab Assistant”.

Fig. 06: EHY-1

The generation of electrical energy using fuel cells continues to develop into a significant area with diverse application potential in electrical engineering and automotive technology.

The training panel system permits a safe experimenting environment in connection with hydrogen and fuel cells. At the same it permits interesting investigations and is well suited for both practical lab work as well as demonstrations. Animated theory, experiment guidelines and information including results are supplied using the "Interactive Lab Assistant".

Training content:

Design and operation of a fuel cell

Design and operation of an electrolyser

Design and operation of a metal hydride storage cell

Thermodynamics of the fuel cell

Characteristics and power curves of the fuel cell Efficiency

Required systems for standalone power supply

Power electronics and voltage conversion

Basic equipment:

Fuel cell with DC converter

Training panel with fuel cell stack, consisting of 10 cells connected in series. The panel contains all of the functioning elements need for the operation of an autonomous fuel cell power supply.

An integrated DC-DC converter with over current limiter generates a stable 12 V

voltage out of the load-dependent voltage of the fuel cell. The integrated interface measures all of the relevant variables, controls the processes and monitors all of the safety-relevant parameters

2.3 France

Name of the materials:	hydrogen industry
Author(s) / Institution:	Johnny Deschamp, ENSTA
Language:	french version and english version
Date of compilation:	2008
Short discription of the contence of the materials:	Chapters : - production - storage - distribution - application - economy
Number of modules / slides / hours of teaching:	it depends of the framework. 21H/32h and the number of slides varies between 50 to 100.
Who is the target-group?	The students of the master or of the engineering school.
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	These materiels are applied in several programs, they are adapted according to the audience. The different frameworks are : master on renewable energy, option in the school ENSTA, in-training formation.
Are the materials accredited? Does the attendee gets a qualifing certificate? or just a certificate of attandence?	The number of ECTS credits varies between 2 to 5 for the module hydrogen according to the framework i is applied.
Are the materials public?	no
Contact:	deschamps@ensta-paristech.fr
Comments:	In some engineer schools in France, the students have to note the courses they follow. The courses on the hydrogen receive good notations.

Fig. 07: hydrogen industry

The courses presented in the figure 7 is used in several courses and adapted according to the number of hours of the module and of the audience.

Those different formations are:

3rd year of engineer formation in the schools ENSTA Paristech, Polytechnique, Arts et Métiers

In-service training organized by EUROSAE ENSTA Paristech, this course is dedicated to engineers and technicians working in companies.

Master renewable energy REST at the engineer school Polytechnique. Industrial partners are linked to formation: Renault, edf, psa, scheider.

Master Energy and advanced materials at the university at Cergy Pontoise

European project ICARE (China-EU Institute for Clean and Renewable Energy) which aims to establish an Intitute of education sino-european for clean and renewable energy at Wuhan, in China.

The contents of the lecture notes cover the complete hydrogen chain from the production to the use. The economical aspects of the hydrogen industry are well described and the students are aware of the global dimension. The technical aspects of the fuel cell are explained in detail, depending on the framework of the courses, students and attendees may have practical exercises or not.

The lecture notes are provided to the students during the lectures, they are not public.

As the lecture is adapted in different versions, and as it deals with global view, this course could be included into a more general formation. The industrial aspects are indeed the heart of the course.

Name of the materials:	hydrogen industry
Author(s) / Institution:	Christophe Turpin, INPT
Language:	french version and english version
Date of compilation:	2008
Short discription of the contence of the materials:	The materiel is composed by : - general knowledges on fuel cells : application, use, production - operationg principles of the different kinds of fuel cells
Number of modules / slides / hours of teaching:	12h divided into the theorical part and the practicle part. 50 slides
Who is the target-group?	the students of the engineering school and the master EcoEnergy
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	The materials are applied within a formation that bring together students of engineer school and student of a master 2 on renewable energy
Are the materials accredited? Does the attendee gets a qualifing certificate? or just a certificate of attandence?	These courses are part of the module "electrochemical components" which represent 3 credit ECTS. Students also learn basis in electrochemistry and in electrical interface and electrocatalysis.
Are the materials public?	no
Contact:	turpin@laplace.univ-tlse.fr

Fig. 08: INPT

The master Eco-Energy in which the course Fuel Cell is included brings together students from two engineer schools (ENSIACET and ENSEEIHT) and external students who want to have a master level in renewable energy. We find a various panel of profiles: engineer students who are specialized in chemical engineering, or in process engineering, engineer students specialized in electrical engineering, students who have finished their studies and want to be specialized in renewable energy and finally workers in a retraining scheme.

This master lasts one year divided into six months of courses and six months of professional training.

Another formation is being studied at the National Polytechnic Institute of Toulouse which would last 3 years and would concern the sustainable development. A large part of the formation will be dedicated to the renewable energy, and would include hydrogen and fuel cell module.

The material attached to this course, and presented in the figure --- is composed of a PowerPoint presentation which is given to the student in a paper version during the lectures, then during the practical session, an exercises manual is given to the students. It contains all the knowledge on the electro-chemical and thermodynamics process related to the fuel cells. The technical parameters are the heart of the contents but the problematic of the economics and industry of hydrogen is also addressed. The practical session allows the students to manipulate fuel cell and determinate by the calculation and measures the optimal parameters of the fuel cell.

As the students come from different courses of studies, and have not the same knowledge, courses on basis on electrochemistry, on electrochemical components and on electro catalysis are also provided into the module electrochemical components and represent 44 hours of lectures and exercises. This course is very precise on the technical aspects, we can imagine including it in another program on renewable energy or more generally on new technologies, addressed to a specialized audience because a minimum of knowledge is required to follow this formation

Name of the materials:	hydrogen industry
Author(s) / Institution:	Helion (subsidiary company of AREVA)
Language:	french version
Date of compilation:	2008
Short discription of the contence of the materials:	Contents : • A 1 kW electrical and 1 kW thermal fuel cell • A fuel cell simulator • Educational content integrating typical works, courses updated by teachers or students
Number of modules / slides / hours of teaching:	There is a software containing different type of simulating conditions
Who is the target-group?	all the structures which propose formation on fuel cells
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	It constitutes a complete teaching aid for the pratical exercices on fuel cell.
Are the materials accredited? Does the attendee gets a qualifing certificate? or just a certificate of attandence?	This didactic test bed has been labelized by the cluster "Capenergies" specialized in the clean energies.
Are the materials public?	no, it is commercialized by helion
Contact:	http://www.helion-hydrogen.com/
Comments:	The elaboration of this didactic test bed has been the outcome of a project supported by the unique inerministerial founds fonds (FUI), and held by helion. Academic partners and a SME have also participated to the project.

Fig. 09: Helion

This material is mainly constituted by a fuel cell PEM delivering 1kW electrical and 1kW thermal and software which allow users to simulate different variations of the parameters. The theoretical contents of the software constitute basic knowledge on hydrogen and fuel cells and can be completed by teachers.

The particularity of this didactic test bed is that it has been elaborated by different partners in an educational aim: it can be used from the secondary school to the university.

The partners are:

- The school Polytechnique, the universitary technological institute (IUT) of Marseille and the Ecole des Mines (Armines) who have contributed to the definition of the specifications of the system, to the creation of the educational notes and to the managing of the tests in real conditions ;

- The company CAPSIM playing a role in the simulation engineering;

- The association Alphea Hydrogène, for the dissemination of the information on hydrogen and its applications

BAHIA didactic test beds are found now in several universities and engineering schools (not really in secondary schools yet) and it is used at different levels of formation (bachelor, master). It has been commercialized in 2009.

The possibilities of the material cover:

-the fuel cell system study: stack and auxiliaries to optimize the overall system operation,

-fuel cell applications: programming of miscellaneous profiles for a better understanding of the technology use in back-up generator systems, naval applications, energy storage in conjunction with renewable energy sources, and cogeneration applications...

2.4 United Kingdom

Name of the materials:	Renewable Energy Flexible Training Programme (REFLEX)
Authors / Institution:	Institute is Newcastle University
Language:	English
Date of compilation:	Intake for course taken on every year
Short description of the contents of the materials:	The **REFLEX** programme consists of 12 modules of which one module is Hydrogen & Fuel Cell technology. Components of this module consist of: Appropriate physical chemistry, Electrochemical Power sources, reactor engineering, hydrogen reforming technology, hydrogen storage, hydrogen production, hydrogen economy, fuel cell technology, battery technology, supercapacitor technology
Number of modules / slides / hours of teaching:	The theory consists of 5 days insensive learning via lectures, presentations, case studies and practical training
Who is the target-group?	People who would like to work or are currently working in the Renewable Energy sector
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	In an existing course ie REFLEX, via lectures, presentations and discussions.
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	Hydrogen and Fuel Cell module forms part of either a Post Graduate Certificate, Post Graduate Diploma and MSc in Renewable Energy. The 12 modules can be taken as individual modules however ther will be no associated accreditation associated with this.
Are the materials public?	No
Contact:	http://www.ncl.ac.uk/sage/postgrad/taught/reflex/
Comments:	REFLEX is an innovative postgraduate programme in Renewable Energy offered by Newcastle University. First delivered in 2005, the programme offers MSc, Postgraduate Diploma and Postgraduate Certificate qualifications, delivered by a combination of distance learning and intensive school. In addition, all modules are available as stand alone continuing Professional Development (CPD) modules. The course provides a fully integrated programme covering mechanical, electrical, chemical, marine engineering, geothermal energy, PV, Policy, Ethics and Energy Management.

Fig. 10: REFLEX

http://www.ncl.ac.uk/postgraduate/funding/search/list/malpasREFLEX is an innovative postgraduate programme in renewable energy offered by Newcastle University. First delivered in 2005, the programme offers MSc, Postgraduate Diploma and Postgraduate Certificate qualifications, delivered by a combination of distance learning and intensive schools. In addition, all modules are available as stand alone Continuing Professional Development (CPD) modules. REFLEX provides a fully integrated training programme covering mechanical, electrical, chemical, marine engineering, geothermal energy, photovoltaic, policy, ethics and energy management associated with renewable energy systems. REFLEX is accredited as further learning for CEng status by 5 professional institutions: Energy Institute; IMarEST; IMechE; IET & IchemE.

Each module is delivered by a combination of distance learning material and a one-week intensive school. Pre-school distance learning material is usually made available 6 weeks prior to the intensive school. The intensive school consolidates the information learnt in pre-school study, and on most modules, students will be examined on this material at the end of the week. A post-school assignment is set on some modules, to be completed within one month from the end of the intensive week. Assessment criteria for each module are stated on the module outline forms. All modules are 10 credits. The aim of the module is to provide students with comprehensive and systematic knowledge of the use of hydrogen, electro technical power sources and fuel cells in the energy sector. In particular, the module will focus on the opportunities for using hydrogen, how it is produced and fuel cell technology. The module provides essential material for the hydrogen economy and fuel cell technology, in particular the opportunities for using hydrogen; the use of hydrogen in a hydrogen economy; hydrogen production / generation, storage and distribution of hydrogen as a fuel; future potential methods for generating hydrogen based on renewable energy or fuels. The module also addresses thermodynamic & kinetic principles of electrochemical power sources and fuel cells, and current fuel cell technologies available. Appropriate physical chemistry: units, thermodynamics, kinetics and basic electrochemistry. Electrochemical power sources (batteries and capacitors.) Reactor engineering (Introduction to chemical engineering, material and energy balances, heat transfer separation processes and process design) Hydrogen reforming technology, Hydrogen Storage, Hydrogen Production, Hydrogen economy,

Fuel Cell Technology, Battery technology, Super capacitor technology. It is anticipated that students who successfully complete this module will be able to: Demonstrate a comprehensive and systematic knowledge and understanding of hydrogen systems, storage, production and its application in fuel cells. Demonstrate a comprehensive and systematic understanding of the basic principles of electrochemical power generation systems including batteries, capacitors and fuel cells. Through the use of appropriate insight, be able to develop and design appropriate hydrogen energy systems for use with fuel cell systems.

At the end of this module students should be able to demonstrate a critical understanding of chemical engineering concepts applied to hydrogen energy systems. Demonstrate a critical understanding of theoretical concepts and practical implementation associated with hydrogen and fuel cells in energy systems.

Apply engineering design principles to electrochemical and hydrogen energy systems in a variety of familiar and novel contexts. They should also possess the following cognitive skills: The ability to collate, analyse and evaluate data associated with the selection and design of fuel cell systems. The ability to identify and solve problems, produce and appraise solutions for fuel cell systems in renewable energy systems. The ability to apply design tools for electrochemical, hydrogen power systems. They should also possess the following transferable skills: Problem solving skills applied to open-ended hydrogen system design. Communication skills developed through assessed work and class discussions.

With the focus on guided independent study, the pre-school reading material will enable fundamental understanding of Hydrogen & Fuel Cell technology. This will be reinforced in lectures, tutorial and class exercise sessions during the intensive school week. The assignment will provide students with the opportunity to develop and demonstrate their knowledge and understanding of the use of hydrogen and fuel cell systems. This knowledge and understanding will also be assessed via the unseen written examination. Subject specific, cognitive and communication skills will also be assessed through both the written examination and assignment. The other key skills will not be assessed but students will need to utilise these skills in order to access the self guided material and prepare assignments.

Name of the materials:	Fuel Cell Introduction course
Authors / Institution:	Pure Energy Centre, Shetlands, Scotland
Language:	English
Date of compilation:	Usually once a year
Short description of the contents of the materials:	Hydrogen Safety Fuel Cell Introduction Fuel Cell System Fuel Cell Market and Application Hydrogen Storage Fuel Cell Lab Site visit and FC demonstration Fuel Cell Install guide
Number of modules / slides / hours of teaching:	Course consists of presentations, lectures, tutorials. Courses usually over 2-3 days
Who is the target-group?	The hydrogen fuel cell introductory course is suitable for engineers and technicians working in or entering the fuel cell industry. It is also suitable for employees of industries that have recently invested or plan to invest in fuel cell technology. It is aimed at science and engineering graduate students as well as faculties whose expertise lie in other fields and are looking to enter the field of fuel cells. The course will be valuable to people who wish to acquire a quick working knowledge of fuel cells to utilise this information at work.
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	Material applied via lectures, presentations, demonstrations. These are stand alone courses and not linked with any existing courses
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	Not sure regarding certificate (perhaps a certificate of attendance), however this course is not accredited
Are the materials public?	No
Contact:	http://www.pure.shetland.co.uk/html/Training_courses.php
Comments:	Course benefits Transfer of knowledge for designing a hydrogen fuel cell project · Acquire an understanding on how to install a fuel cell · Learn the basic principles of hydrogen fuel cells technologies · Become hydrogen safety conscious · Learn the unique hydrogen properties for a safe design of an installation · Look at an operational renewable hydrogen facility · Reduce project implementation timeframes by learning from practical experience

Fig. 11: Pure Energy Centre

The Pure Energy Centre is an independent engineering and consultancy company specialising in the design, development, resource assessment and project management of clean energy technologies. The Pure Energy Centre is a world renowned independent multi-disciplinary engineering consultancy specialising in clean energy technologies. Offering professional services for clients, we have the capability to deliver projects right through from feasibility studies to installation and commissioning.

On site Hydrogen production - The Pure Energy Centre design complete hydrogen systems using state of the art electrolysers to produce both hydrogen fuel and oxygen. All their equipment is provided with all necessary auxiliary items for the safe and reliable onsite hydrogen production. All Pure Energy® Centre Electrolyser solutions are available up to 12 bar output pressure with a variable operational range between 20% and 100% of its rated output capacity.

Introduction to Fuel Cells

- Transfer of knowledge for designing a hydrogen fuel cell project

- Acquire an understanding on how to install a fuel cell

- Learn the basic principles of hydrogen fuel cell technologies

- Become hydrogen safety conscious

- Learn the unique hydrogen properties for a safe design of an installation

- Look at an operational renewable hydrogen facility

- Reduce project implementation timeframes by learning from practical experience.

The hydrogen fuel cell introductory course is suitable for engineers and technicians working in or entering the fuel cell industry. It is also suitable for employees of industries that have recently invested or plan to invest in fuel cell technology. It is aimed at science and engineering graduate students as well as faculties whose expertise lie in other fields and are looking to enter the field of fuel cells. The course will be valuable to people who wish to acquire a quick working knowledge of fuel cells to utilise this information at work.

Authors / Institution:	University of Ulster
Language:	English
Date of compilation:	Usually once a year
Short description of the contents of the materials:	Subjects covered include: Introduction to fuel cells and hydrogen, basic thermodynamics and system analysis of fuel cells, hydrogen as an energy carrier- production utilisation, hydrogen storage technologies - compatability of materials with hydrogen, safety-hydrogen release & dispersion, hydrogen storage, distribution & infrastructure, tutorial in unignited jets, overview on polymer electrolyte fuel cells, high temperature proton exchange fuel cells, safety-hydrogen fires, tutorial on hydrogen fires, safety-deflagration, safety-detonations, molten carbonate fuel cells & solid oxide fuel cells, practical work, tutorial on polymer electrolyte fuel cells, European projects & politics, information sources and networks, fuel cell application and development challenges, practical work, tutorial on deflagrations and detonations
Number of modules / slides / hours of teaching:	Course consists of presentations, lectures, tutorials and practical sessions. Courses usually over 3-5 days
Who is the target-group?	The International Short Course and advanced research workshop is ideally suited to those who wish to meet the growing demand for specialists in Hydrogen Safety Engineering i.e. industries and services such as aerospace, process industry, energy industry, civil works, transport and distribution, fire and rescue services, regulatory authorities, teaching and research institutes, various industrialist co operations, consultancies etc. The course is aimed at researchers, professionals, industrialists and those who have an interest in working with hydrogen in this new and rapid advancing field.
Where are the materials applied? **(in a existing course, lecture, seminar? in a new offer?**	Existing course via presentations, lectures, tutorial and practical work. These are stand alone training courses on Hydrogen safety, however they also form part of a University of Ulster Post Graduate Certificate, Diploma, MSc in Hydrogen Safety.
Are the materials accredited? Does the attendee gets a qualifying certificate? or just a certificate of attendance?	Not sure regarding certificate (perhaps a certificate of attendance), however this course could form part of an academic MSc which has the possibility of being accredited
Are the materials public?	No
Contact:	http://hysafer.ulster.ac.uk/

Comments:	The HySAFER centre at the University of Ulster focuses on the area of hydrogen safety and the phenomena associated with potential hydrogen accidents (leaks, explosions, fires etc.). In addition to research, the centre is actively involved in the development of education programmes in hydrogen safety, including short courses. The research activities of HySAFER range from fundamental work to ground breaking applications and primarily include computer simulations, and consequence modelling, of potential accident scenarios.

Fig. 12: Hydrogen Safety

The HySAFER group is a leader of the International e-Academy of Hydrogen Safety (http://www.hysafe.org/eAcademy) in the framework of the CEC FP6 NoE HySafe project. The International Curriculum on Hydrogen Safety Engineering was developed under the HySafe funding with contribution of some 50 leading experts throughout the world (http://www.hysafe.org/eAcademyCurriculum). Teaching materials of highest quality are being developed by renowned scientists and industrial experts in the framework of coordinated by the HySAFER group the CEC FP6 MC HyCourse project "European Summer School on Hydrogen Safety" (ESSHS). The first ESSHS, held in August 2006 in Belfast, was a great success, the second ESSHS, held in July-August 2007, confirmed the international leadership of UU in the area of hydrogen safety education and training, the third ESSHS (21-30 July 2008) included 5 Keynote Speakers from Sandia National Laboratories and NASA and was co-funded by the US Department of Energy demonstrating UU's importance and leadership in hydrogen safety education worldwide.

Leading by the principle "excellence in teaching through research" the HySAFER group inaugurated, in January 2007, the on-line delivery of the world's first higher education programme - Postgraduate Certificate in Hydrogen Safety Engineering.

These International Hydrogen Safety short courses (those above held in 2009 and 2011 respectively) are suited to those who wish to meet the growing demand for specialists in Hydrogen Safety Engineering i.e. industries and services such as aerospace, process industry, energy industry, civil works, etc. The courses are aimed at researchers, professionals, industrialists and those who have an interest in working with hydrogen in this new and rapidly advancing field.

Specific subjects covered include: Introduction to fuel cells and hydrogen, basic thermodynamics and system analysis of fuel cells, hydrogen as an energy carrier – production utilisation, hydrogen storage technologies – compatibility of materials with hydrogen, safety-hydrogen release and dispersion etc.

These courses are stand alone training courses on Hydrogen safety, however they also form part of a University of Ulster Post Graduate Certificate, Post Graduate Diploma, MSc in Hydrogen Safety.

This programme is the world's first higher educational programme that enables graduates to specialise in this new and rapidly advancing field. It is taught by research-active staff members from the Hydrogen Safety Engineering and Research Centre (HYSAFER Centre), experts from the International Association for Hydrogen Safety, keynote speakers at the European Summer School on Hydrogen Safety and experts from all over the globe at the International Short Course Series Progress in Hydrogen Safety. The programme is designed to equip you with the skill-set needed to cope with hydrogen safety problems in the basic processes of the hydrogen economy and the ability to acquire new and further skills needed for the provision of hydrogen safety as the hydrogen economy evolves and new knowledge becomes available. In addition to providing a systematic understanding of the scientific/technological principles and techniques involved in hydrogen safety, this programme aims to develop the skill and expertise to apply this knowledge to the provision of safety in a wide range of hydrogen applications.

The programme is intended for students who are pursuing careers in hydrogen safety, and for professionals already working in industry (process industry, energy industry, civil works, aerospace industry, automotive industry), transport and distribution, fire and rescue brigades, insurance, teaching institutions, research institutions and legislative bodies.

Conclusions

The most positive conclusion of this report is the fact that hydrogen teaching and training materials exist in all countries which were involved in this report. That gives the particular countries the possibility to develop the needs for managing the changes from fossil energy system into a renewable energy based system.

The hydrogen teaching and training materials developed in different European countries are singular at the moment which means that they are currently used in pilot actions, study courses and other individual seminars. They are not standardized by a European accreditation body and they are mostly implemented in professional or academic curricula. Due to the different educational systems in the European countries the accreditations of the hydrogen teaching and training materials are not in the same way.

Another message of the hydrogen and fuel cell educational material assessment is the fact that the materials have been used as part in existing study programs. The reason could be seen in avoiding risks to set up a primary hydrogen and fuel cell study course. It was the core massage occurred in an interview with someone who is involved in the only existing primary hydrogen and fuel cell study course the “Hydrogen Technology” Master of Science study program provided by the Dresden International University in Dresden, Germany.

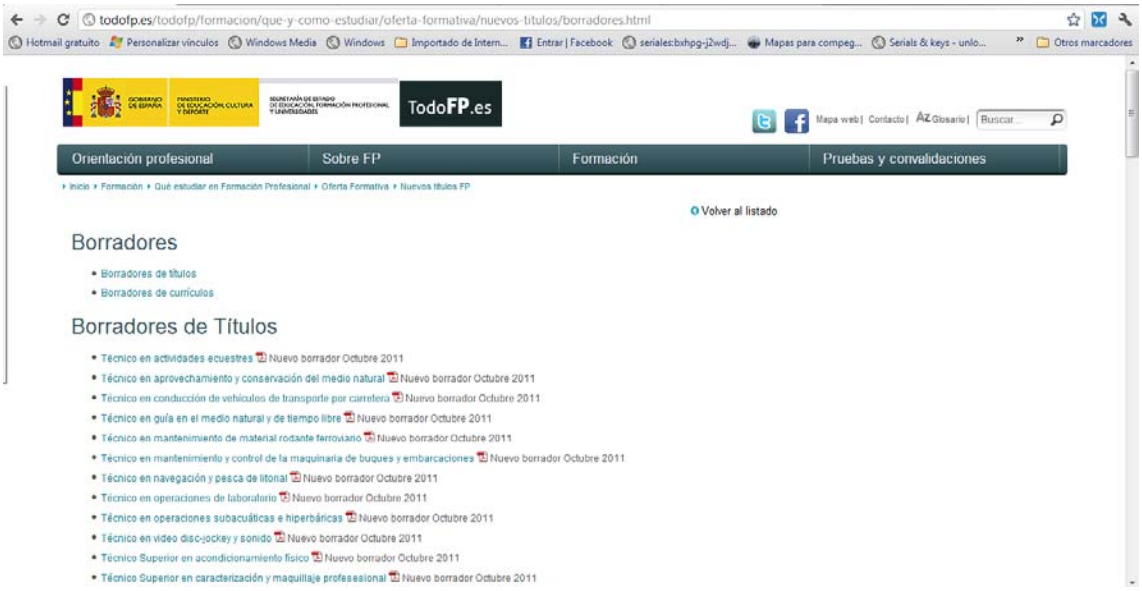
Annex

Spain

VOCATIONAL TRAINING

Every year, new *qualifications* are issued or other existing ones are enhanced by the Ministry of education in Spain. These *qualifications* belong to the different study areas corresponding to vocational training. There is not a specific moment in the year when the Ministry issues the *qualifications*: it is required to often check the web site where these *qualifications* are published. This is the web site:

http://todofp.es/todofp/formacion/que-y-como-estudiar/oferta-formativa/nuevos-titulos/borradores.html



(All these *qualifications* are published in the referred website as drafts).

The *qualifications* represent the 55% of the total studies plan for every degree in vocational training and are defined by the academic teams of the Ministry of Education. They indicate the guide lines of every degree, previous knowledge of the students and the final skills and certificates to reach by the students.

The curriculum represents a 35% of the training material and is established by the Departments of Education in every Autonomous Communities.

The educational centres are in charge of the 10% left, which adapt the studies to the environment of the students.

Once the Ministry of Education shows the new or modified *qualifications*, there is a period of about a month from the publication in web to make allegations in order to modify parts of the *qualifications* or add specific knowledge.

In this period of claims any educational institution in every area can perform the allegations. To make allegations it is required to produce a report specifying the suitability of that knowledge, the way of teaching, and the teaching hours. These reports are analyzed by the internal teams of the Ministry of Education to decide if they are incorporated.

Any person or expert team can propose these allegations, but it is preferable if these allegations come from educational area.

The reports can be sent to the ministry of education headquarters in Madrid.
C/ Los Madrazo, 15
28071, Madrid
Teléfono: 913277681

Although a syllabus is not admitted in the revisions made by the Ministry of Education, there is the chance to include it in the programmes that are revised by the Departments of Education in the Autonomous Communities.

The 35% of the contents in every study plans are decided by the Departments of Education in the Autonomous Communities. This part of the study plan is called C*urriculum*. In this 35% it is included additional contributions to adapt the study plan to the specific economic, cultural and occupational features of the Autonomous Community.

The Department of Education proposes two possible ways to include a new knowledge in the study plans:

On the one hand, the way is similar to the one applied in the Ministry of Education. Every time a curriculum is modified by the technicians of the Department of Education, it is published in a web site from the Department of Education related to vocational training. In Aragón is:

http://fp.educaragon.org/arboles/arbol.asp?sepRuta=&guiaeducativa=42&strSeccion=A3A28&titpadre=Curriculos+aragoneses+de+F.P.&arrpadres=&arrides=&arridesvin=&lngArbol=1743&lngArbolvinculado=

In this web site the modified or new curricula are published. There is a period to make allegations and it is about a month like in the case of Ministry of Education. The procedure is similar to the formerly signed:

To make allegations it is required to produce a report specifying the suitability of that knowledge, the way of teaching and the teaching hours. It is also required indicating in what title they must be incorporated.

Any person or expert team can propose these allegations, but it is preferable if these allegations come from educational area.

These reports are revised by the internal technical teams from the Department of Education in order to decide whether they are appropriate to be incorporated.

The reports can be sent to the Department of Education headquarters in every Autonomous Community.

On the other hand, a knowledge can be added to the academic curriculum by making the same report specifying the suitability of this knowledge and send it to the same Department at any moment of the year. This report is kept waiting to be revised. Each curriculum is revised every 3 or 4 years so that they can be adapted to the new needs that may have arisen. This is the moment when the reports with proposals for new curricula are evaluated by the educational technical teams. The proposals can be applied or denied by these technical teams.

France

VOCATIONAL TRAINING

The French vocational training is called C.A.P., and stands for “Certificat d’Aptitude Professionnelle”. It’s a two-year title delivered by the French Ministry of Education (Ministère de l’Education nationale, Jeunesse et Vie associative).
All the C.A.P. are listed on a Ministerial web site:

http://eduscol.education.fr/cid47637/le-certificat-d-aptitude-professionnelle-cap.html

C.A.P. formations take place into “Lycées” (Secondary education centers), in collaboration with specific centers called C.F.A. (Centres de Formation des Apprentis) and enterprises, where students have their trainings. Any specific knowledge is needed to start a C.A.P. formation.
In order to create or modify a C.A.P. formation, a report has to be sent to the French Ministry of Education. This report, called “Dossier d’opportunité”, has to specify the

suitability of the knowledge, the professional needs, the manner of delivery, and the employment opportunities.

The reports have to been sent to this address:

Ministère de l'Education nationale, de la Jeunesse et de la Vie associative
Direction Générale de l'Enseignement scolaire
A l'attention du Chef de Bureau des Diplômes professionnels
110 rue de Grenelle 75357 Paris SP 07

This report will be read by a Ministerial task group that would evaluate the report and prepare a proposition of new C.A.P. or allegations of yet existing ones. Eight to ten one-day reunions are often necessary to make a final proposition.

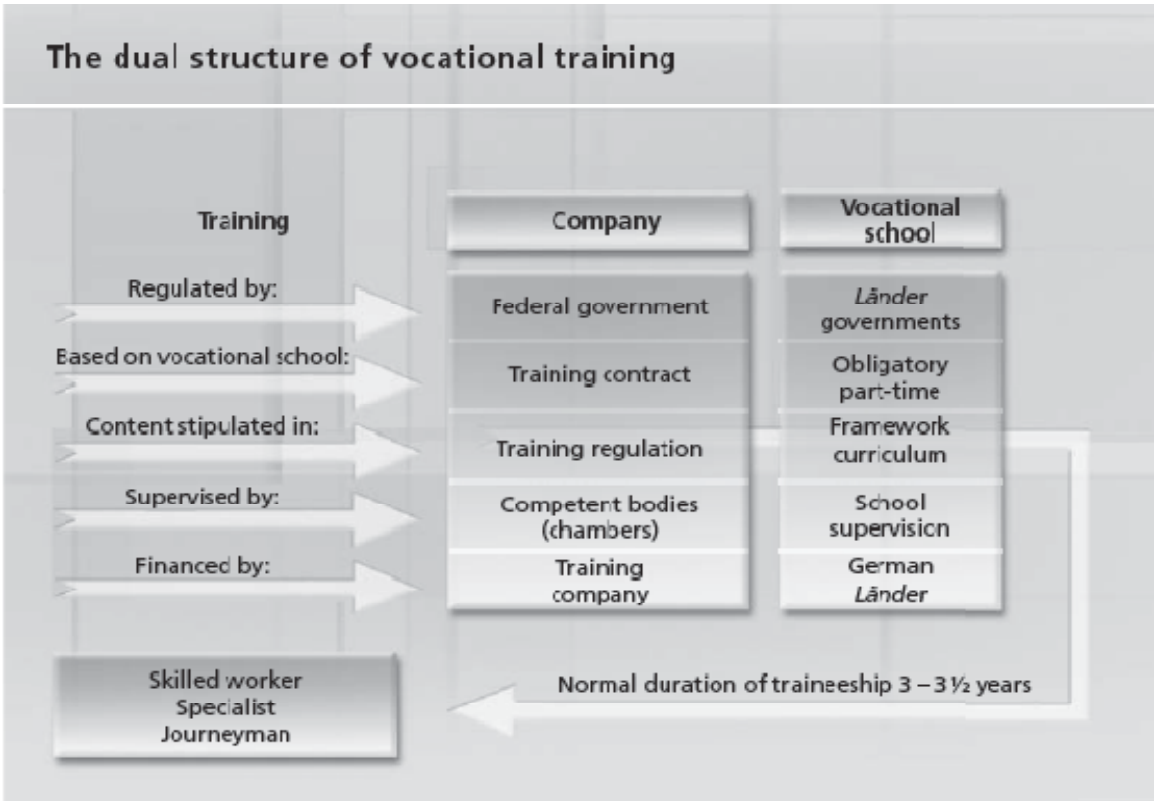
This one would be presented to a Ministerial Committee called "Commission professionnelle consultative" or "CPC" that statue 1 to 3 times a year. There isn't any specific moment in the year for these statements: they depend on the needs and the Ministry agenda.

Reports presented by professional institutions are more appreciated than those presented by educational institutions. They seem to be more successful.
In general, a new C.A.P. have to be presented to the CPC in December the year before the start of the school year. Nine months to one year are general necessary to create a new C.A.P. formation. The modification of an existing one usually needs less time.

For further information, the "Bureau des Diplômes Professionnels" of the French Ministry of Education can be contacted by phone: +33 1 55 55 35 56.

Germany

The German vocational training system, with its combination of classroom and business, theory and practice, learning and working, is a basic and highly effective model for vocational training. An essential characteristic of the dual system is the cooperation between largely private companies, on the one hand, and public vocational schools, on the other. This cooperation is regulated by law. The term “dual” also denotes a specific constitutional situation in Germany, where the federal government is responsible for vocational training in the companies, and the federal states (Länder) for the vocational schools.

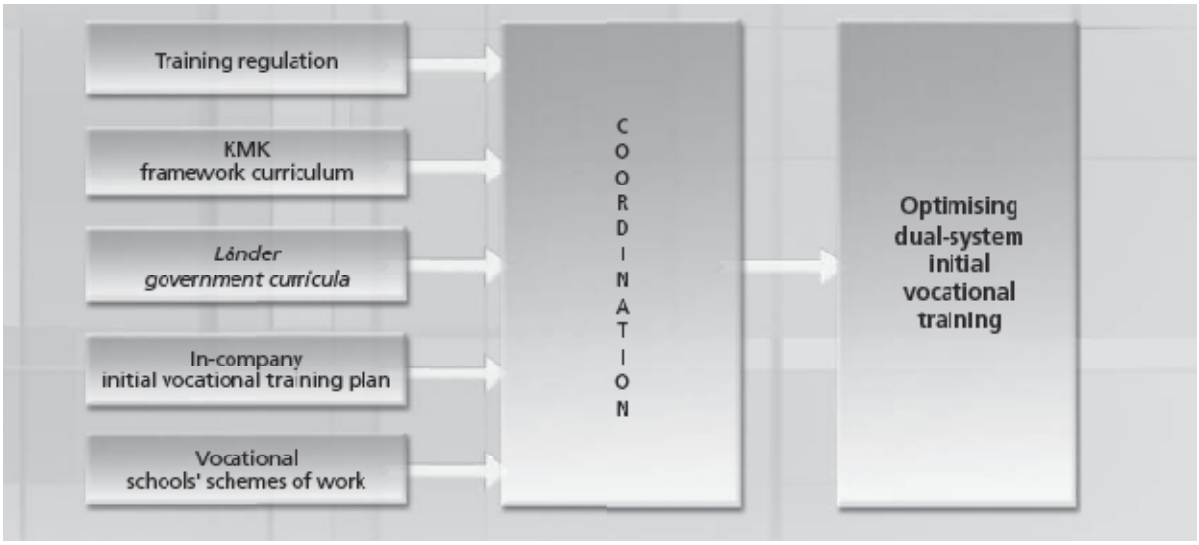


Vocational Training Regulations and the Process Behind Them

The German Vocational Training Act (Berufsbildungsgesetz, BBiG) of 1969 where “vocational training” is meant as vocational training preparation, initial training, further training and retraining was reformed in 2005. The reform entered into force on 1 April 2005. The aim of the law is to equip young people about to enter the world of work

with complete occupational proficiency within a broadly contoured area of work. Only in this way can they meet the constantly changing demands of the workplace. In both the old and the reformed law, the state has declared all non-school-based vocational education a public responsibility, but has nevertheless assigned responsibility for its implementation largely to employers in the private sector and public administrations. All players involved in vocational education work together in planning and preparing the profiles for new or updated occupations:

- the companies and chambers (employers),
- the trade unions (employees),
- Germany's federal states (Länder) and
- The German federal government.



Extract from the 2005 Vocational Training Act:

Part 2

Vocational Training

Chapter 1

Initial Training

Division 1

Organization of Initial Training; Recognition of Training Occupations

Section 4

Recognition of Training Occupations

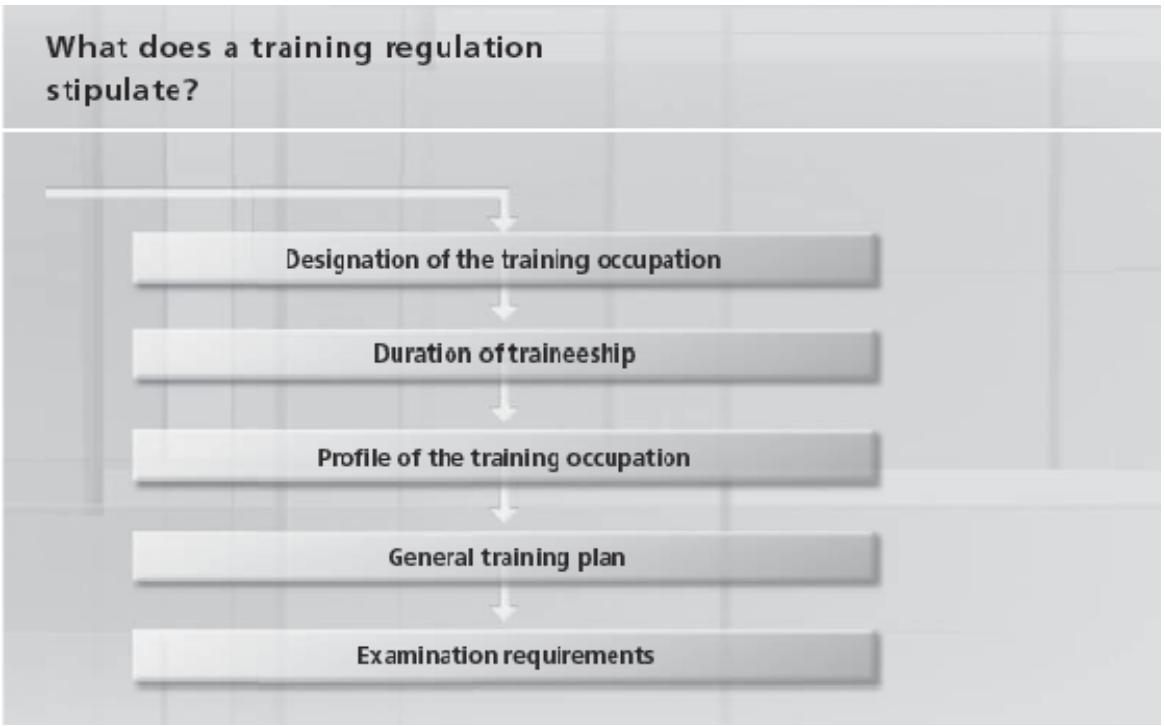
(1) As a basis for an orderly and uniform system of initial training, the Federal Ministry of Economics and Labour or such other ministry as may be competent, acting in agreement with the Federal Ministry of Education and Research, may by ordinance which shall not require the consent of the Bundesrat officially recognize training occupations and issue initial training regulations for such occupations pursuant to section 5.

Section 5

Initial Training Regulations

(1) The initial training regulations shall specify

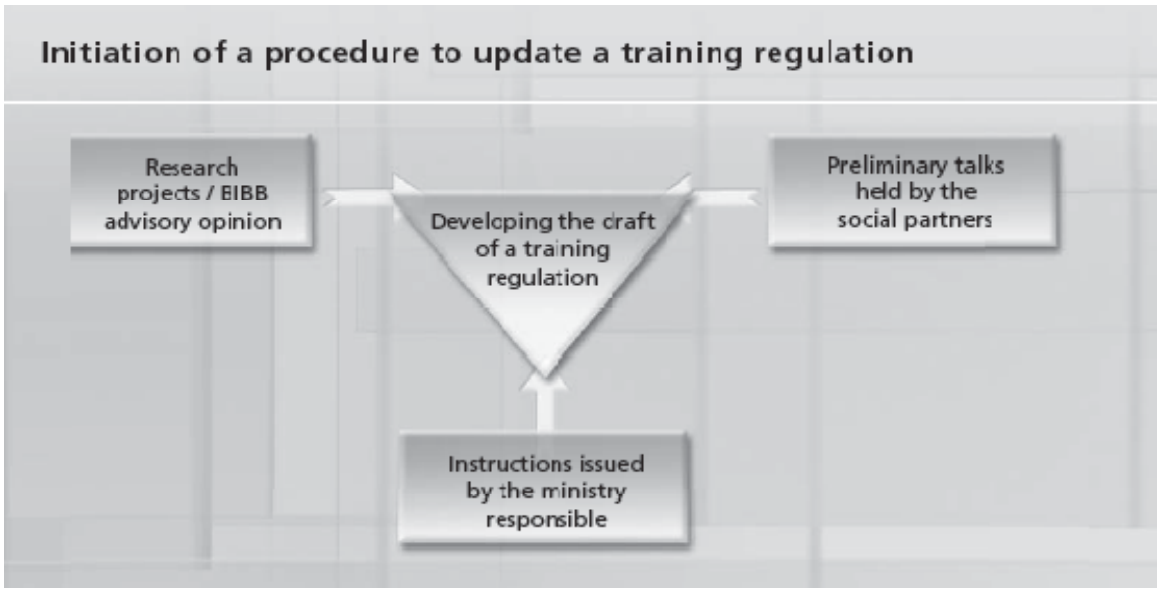
1. the designation of the training occupation to be recognized;
2. the duration of initial training, which shall not be more than three or fewer than two years;
3. the vocational skills, knowledge and qualifications to at least be imparted in the course of initial training (training occupation profile);
4. an outline of the syllabus and timetable to be followed when imparting the vocational skills, knowledge and qualifications (overall training plan);
5. the examination requirements.



BIBB – development centre for new training regulations

As a rule, the initiative for updating the content or structure of a training occupation or for developing an entirely new occupation comes from industry associations, from the top–level employers' organisations, from trade unions or the Federal Institute for Vocational Education and Training. After hearing the views of all the parties concerned, the responsible federal ministry decides in consultation with the *Länder* governments whether to proceed.

The development of new vocational training regulations and framework curricula or the adaptation of existing regulations in response to changes in day-to-day occupational practice follow a systematic procedure. The participants involved are the federal government, the Länder governments, employers, trade unions and the VET research community.



The federal and Länder governments have agreed as a matter of principle to limit the duration of this procedure to one year. As a rule, the experts should complete their work within eight months following the decision by the coordinating committee (the body in which the federal and Länder governments resolve any differences). The federal government's experts support the drafting of the training regulation including

the general training plans for use by companies. They are nominated by the social partners. The Länder experts, nominated by the Standing Conference of Ministers of Education and Cultural Affairs of the Länder (Kultusministerkonferenz, KMK) develop the framework curricula for the part-time vocational schools.

To be responsive to the pace of technological, economic and societal change, vocational training regulations do not stipulate the use of any specific methods or technical systems. They list the targeted learning objectives in a way that is as technology-neutral and function-oriented as possible, so as to remain open to new developments. The subsequent procedure for developing a vocational training regulation consists of the following steps:

- defining the parameters for the vocational training regulation,
- drafting and coordination phase,
- Issuing the ordinance.

These are the steps whereby the application submitted to the responsible ministry results in a new recognised occupation.

Initiating new and updating existing occupations

Proposals regarding the parameters of a training occupation can emerge in different ways:

- out of preliminary talks held by the social partners (employers and trade unions),
- from the findings of research projects conducted or advisory opinions drafted by the Federal Institute for Vocational Education and Training (BIBB),
- from instructions issued by the responsible ministry.

As a rule, the parameters are developed by the social partners when they see a need for creating a new occupation or revising an existing one. Their top-level organisations, the German Employers' Organisation for Vocational and Further Training (*Kuratorium der Deutschen Wirtschaft für Berufsbildung*, KWB) and usually the Confederation of German Trade Unions (*Deutsche Gewerkschaftsbund*) submit the proposed parameters to the body that will issue the ordinance (i. e. the responsible ministry) with the request that they be examined and a meeting be set up to discuss the application.

Support for VET practitioners provided by BIBB

Responsibility for the implementation of training regulations and framework curricula rests with the companies and vocational schools. Nevertheless, support is provided by the Federal Institute for Vocational Education and Training (BIBB, www.bibb.de) through publications, diverse advisory work such as implementation guidance on training regulations ("Structuring Training") and other support.

Conclusion

The German government uses laws and regulations to regulate the legal framework for vocational training in the „dual" vocational training system (which combines part time vocational schooling with practical work experience). Legal provisions that outline the aims and content of and examination requirements for in-company training are training regulations.

The Federal Institute for Vocational Education and Training prepares the content of training regulations for the government. It develops drafts together with on-the-ground experts from the actual vocational training field who have been delegated by management and labour.

Experts from initial vocational training practice work jointly with the Federal Institute for Vocational Education and Training (BIBB) on the drafting of new training regulations, and they confer with experts from the part-time vocational schools in order to coordinate these regulations with the draft framework curricula. Employers and trade unions then publicise the new training regulations in their firms, and the federal government enacts them in law.

All Information taken from the brochure "Vocational Training Regulations and the Process Behind Them", Federal Institute for Vocational Education and Training (BIBB) 53142 Bonn, Germany, 2011.

United Kingdom

There is no formal definition of 'vocational education' in England, and the term is applied to programmes as different as the highly selective, competitive and demanding apprenticeships offered by large engineering companies and the programmes which recruit highly disaffected young people with extremely low academic achievements.

Some qualifications are highly specific, oriented to a particular occupation. Others are more general, and are referred to sometimes as vocationally-related or pre-vocational. Some are very difficult and demanding, others not. A particular qualification can serve different groups, some with a clear career goal and others without, just as for a particular individual, a combination of the highly specific and the highly general may be more appropriate than just one or just the other.

The regulatory Framework

In the context of vocational education, two aspects of the current regulatory apparatus are critically important, and also contribute to a number of the issues and problems. They are:

- the Sector Skills Councils (SSCs)
- Office of Qualifications and Examination Regulation (Ofqual) Ofqual's regulatory activities, notably of individual qualifications

The SSCs – which are non-statutory – have become, in the last few years, de facto designers, as well as de facto first-line accreditors, of almost all non-Higher Education qualifications other than the academic ones. In some cases, they play a very active part in deciding which awarding bodies will be allowed to offer a qualification in a given area. They were also central to the design of the Diploma. There are currently twenty-five SSCs, covering about 85 per cent of the British workforce (examples include Cogent www.cogent-ssc.com is the Sector Skills Council for the Chemical, Pharmaceutical, Nuclear, Oil and Gas, Petroleum and Polymer industries and SEMTA (www.semta.org.uk/) is the Sector Skills Council for Science, Engineering and Manufacturing Technologies).

SSCs exist to represent and articulate the view of employers. However, they do not develop organically, in the way that trade and professional bodies do, but are instead created by government, and largely funded by it. The number of SSCs is determined centrally, rather than evolving from and with the labour market; and SSCs can be, and are, closed down, or forcibly merged, if they are judged to be performing inadequately.

SSCs also develop apprenticeship frameworks, and decide precisely which nationally-accredited qualifications may be used within a given framework.

Ofqual is the 'Office of Qualifications and Examinations Regulation'. While it has a number of different functions, a great deal of its effort is directed to accrediting individual qualifications; Ofqual's role is to regulate qualifications.' It is a relatively new body, which has absorbed a number of functions and activities from the Qualification & Curriculum Authority (QCA).

Ofqual has, to date, been accrediting individual qualifications in their thousands, as well as regulating awarding bodies. (Qualifications are not accredited unless they are awarded by an approved awarding body.) Ofqual itself creates the criteria against which it regulates and accredits and cannot be over-ruled formally by the Secretary of State, although it can be directed to take account of governmental policies. However, the decision on whether or not a qualification (accredited or otherwise) can be funded for use in education rests with the Secretary of State, the only exception being apprenticeships.

Ofqual is also charged with monitoring standards. Its remit in this respect will be modified under the current Education Bill, which requires it explicitly to take account of international qualifications. However, to date, like its predecessor body QCA, it has confined itself overwhelmingly to monitoring standards by comparing written documents, rather than comparing standards in any direct way.

Types of Vocational Training

In the past, many young people worked part-time and studied part-time on day release. BTEC National Certificates (NC) and Higher National Certificates (HNC) were developed for this route. NC's and HNCs had more of a general education component than most apprenticeship frameworks. Interestingly many young people used to find jobs at 16 in business and commerce and go to college for one day a week to study for their BTEC…Today, young people might progress on to an apprenticeship in business and commerce and are then forced to study NVQs….cutting off the opportunities to progress."

In the UK the most prominent vocational programs include:

(a) The Business and Technology Education Council (BTEC) Awards

BTEC qualifications originated with the 'Technician Education Council' and 'Business Education Council' (which then merged), and were originally developed as technician level awards, and offered in further education only (and not schools, which were not considered to have adequate facilities.) The BTEC National Diplomas and National Certificates are 'level 3' awards (like A (Advanced) levels) and date back to the 1970s. By contrast, BTEC 'First Certificates' were introduced later to provide an alternative qualification and, ideally, a progression route to National level, for the increasing number of 16 year olds staying in full time education.

BTEC qualifications are undertaken in vocational subjects ranging from Business studies to Engineering. They are equivalent to other qualifications such as the General Certificate in Secondary Education GCSE (levels 1 to 2), A Level (level 3) and university degrees (levels 4 to 7).

(b) National Vocational Qualification (NVQ)

NVQs - National Vocational Qualifications - are a very significant part of the UK training and development landscape. Introduced first in 1986 by the specially formed National Council for Vocational Qualifications, NVQs have enabled millions of people of all ages in almost all imaginable trades and professions to achieve formal qualifications.

While offering basic entry-level qualifications in most trades and skills, many NVQ awards also represent a seriously high standard of competence, comparable to anything a top university might offer, equating to degree level and beyond.

Not everyone loves NVQs. For various reasons some people, and some organisations have found them tricky to understand. The recent and ongoing changes and development affecting the NVQ system are partly in response to this, although changes are largely driven by much deeper considerations of improving workplace skills and developing UK national competitiveness in an increasingly competitive global market.

NVQs are not just qualifications - NVQs are a **system of learning and accreditation** as well, which is itself open to a variety of interpretations.

NVQs in the UK are now progressively being replaced with QCF (Qualifications and Credit Framework) awards, certificates and diplomas. As at 2010 this transition is in progress.

Scottish Qualifications Authority (SQA)

In Scotland, where the system of vocational education and training differs from that of the rest of Britain, the Scottish Qualifications Authority (SQA) accredits all Scottish Vocational Qualifications (SVQs). Contact details: Scottish Qualifications Authority (SQA), Hanover House, 24 Douglas Street Glasgow. G2 7NQ Tel: 0141 248 7900. Web: sqa.org.uk

(c) City and Guilds Qualification

The **City and Guilds of London Institute** (**City & Guilds**) is a leading UK vocational education organisation. City & Guilds offers more than 500 qualifications over the whole range of industry sectors through 8500 colleges and training providers in 81 countries worldwide. Two million people every year start City & Guilds qualifications, which span all levels from basic skills to the highest standards of professional achievement (Honours, Master and Doctorate levels equivalent).
Founded in 1878 by the City of London and 16 livery companies – the traditional guardians of work-based training – to develop a national system of technical education, City & Guilds has been operating under Royal Charter (RC117), granted by Queen Victoria, since 1900.

Nowadays City & Guilds continues as an examination board offering a large number of qualifications mapped onto the British National Qualifications Framework (NQF). The most common are the vocational qualifications, from Entry-level to Level 3.

- **Entry-level** qualifications are the real basics, for absolute beginners.
- **Level 1** qualifications are introductory awards, covering basic tasks and knowledge.
- **Level 2** is slightly more advanced, needing some knowledge of the subject area.
- **Level 3** qualifications cover more complex tasks and also start the development of supervisory skills. In many professions, level 3 is the benchmark to be considered competent.

These qualifications are now mapped onto the new Qualifications and Credit Framework (QCF).
The range of qualifications cover the 'traditional' areas such as engineering, craft skilled trades, health and social care, hairdressing, automotive maintenance, construction, and catering, but also the more obscure such as sheep shearing, DJing, flower arranging.

(d) Apprenticeships

Apprenticeships have a long tradition in the United Kingdom in the 1970's Apprenticeships used to be the main route from secondary school to skilled training in traditional 'trade' professions such as fitters, electricians, plumbers etc. Over the years apprenticeships declined nationally in many cases being replaced by other Government initiatives such as the Youth Training Scheme (YTS).

Company-based apprenticeships are highly valued. Qualifications gained within apprenticeships have very high positive returns, when the same qualifications gained elsewhere do not. This may be partly because the actual training and skill levels are different, but is also likely to reflect, to a considerable degree, the fact that the return to the qualification is, in this case, actually measuring/capturing returns to apprenticeship and work experience directly.

Apprenticeships are organised around 'apprenticeship frameworks' drawn up by Sector Skills Councils, and currently are non-age-specific.

A major difference between current UK/English apprenticeships and those offered in other European countries is the small proportion offered at Level 3 (and the correspondingly large number at level 2.) These also require much less general education; and permit all training to take place on employers' premises, whereas in other countries attendance at college or apprenticeship centres is the rule. The small number of level 3 apprenticeships and the very limited general education component in apprenticeship frameworks severely constrain the numbers who can plausibly progress from apprenticeship to higher education.

Apprenticeships are now experiencing something of a renaissance and there is currently much more interest in the development of apprenticeships in the UK.

In 2010, Pearson Work Based Learning (http://pearsonwbl.edexcel.com/pages/homepage.aspx) launched its new brand of Apprenticeship combining the established Edexcel BTEC brand and a number of technology solutions to form BTEC Apprenticeships offering Apprenticeships across over 20 different job sectors.

Employers who offer apprenticeship places have an employment contract with their apprentices, but off-the-job training and assessment is wholly funded by the state for apprentices aged between 16 and 18. In England, Government only contributes 50% of the cost of training for apprentices aged 19 and over.

Government funding agencies (in England, the Learning and Skills Council) contract with 'learning providers' to deliver apprenticeships, and may accredit them as a Centre of Vocational Excellence or National Skills Academy. These organisations provide off-the-job tuition and manage the bureaucratic workload associated with the apprenticeships. Providers are usually private training companies but might also be Further Education colleges, voluntary sector organisations, Chambers of Commerce or employers themselves.

Examples of types of Apprenticeship sectors